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User manual for CaneLCA Eco-efficiency Calculator V1.01

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BSES
Sugarcane for the future

The University Of Queensland
AUSTRALIA

Australian Government
Sugar Research and Development Corporation

CaneLCA Eco-Efficiency Calculator
for Australian sugarcane producers
(Version 1.01)

User Manual

for CaneLCA Eco-efficiency Calculator V1.01

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INTRODUCTION

About CaneLCA

CaneLCA calculates the eco-efficiency of sugarcane production over its lifecycle, to help sugarcane producers and their advisors identify sustainable farming practices. CaneLCA can assist sugarcane producers to:

- understand on-farm and off-farm environmental impacts
- identify where environmental impacts can be reduced
- compare the eco-efficiency of different combinations of cane growing practices
- verify the environmental benefits of new cane growing practices
- inform decisions about changes to current farming practices.

It was developed jointly by the University of Queensland and BSES Limited with funding from the Australian Government and the Australian sugar industry through the Sugar Research and Development Corporation (SRDC) (Project UQ045).

CaneLCA is based on environmental life cycle assessment (LCA). It considers the environmental aspects across the life cycle of sugarcane production from 'cradle to farm gate' (see Figure 1). This includes the production of inputs to sugarcane growing (fertilisers, minerals, chemicals, capital goods, water, fuels and electricity), the transport of inputs to the farm, and the environmental emissions that occur on the farm.

It calculates environmental indicators for a range environmental aspects known to be important for sugarcane growing – ENERGY USE, CARBON FOOTPRINT, WATER USE, and WATER QUALITY.

CaneLCA is designed to make the LCA process as streamlined as possible for the user. The user enters data describing the practices for a given sugarcane farm. The tool then uses in-built calculations, assumptions, and environmental emission factors to calculate the relative eco-efficiency indicators per tonne of cane.

The results are presented as an environmental profile graph with eco-efficiency ratings for each aspect (see Figure 2). Users can interpret from the graph the sources of environmental impacts and opportunities for improving eco-efficiency. The assessment can be repeated for different combinations of cane growing practices so the user can compare the eco-efficiency of different practice options.

Calculations performed in CaneLCA comply with LCA carbon footprinting standards (ISO14042, PAS2050, ISO14064).

Figure 1 Scope of activities assessed by CaneLCA

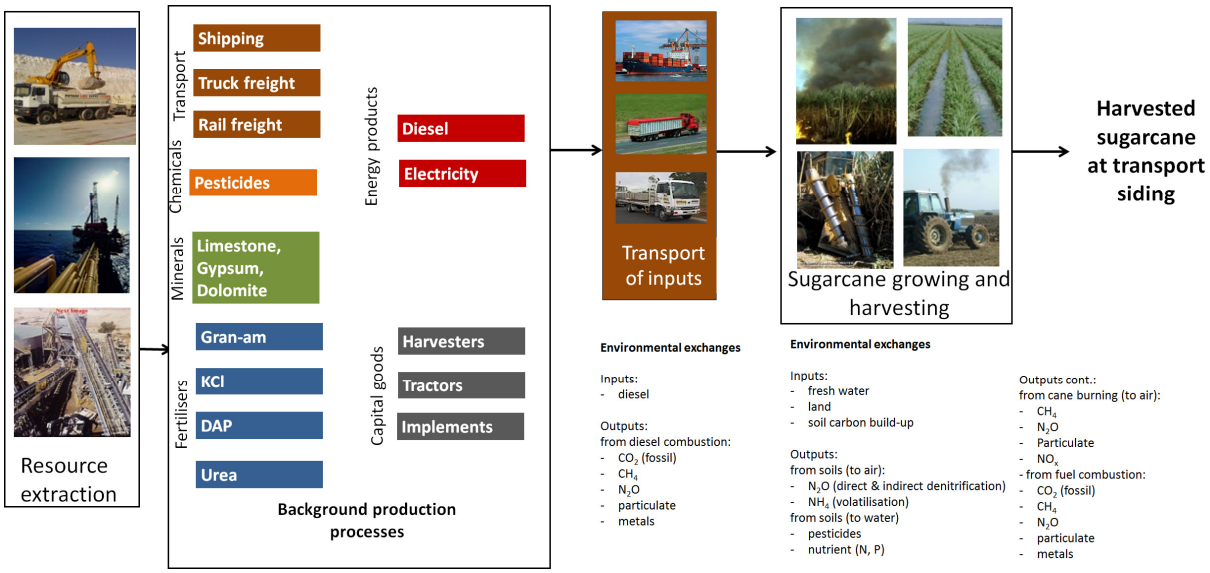
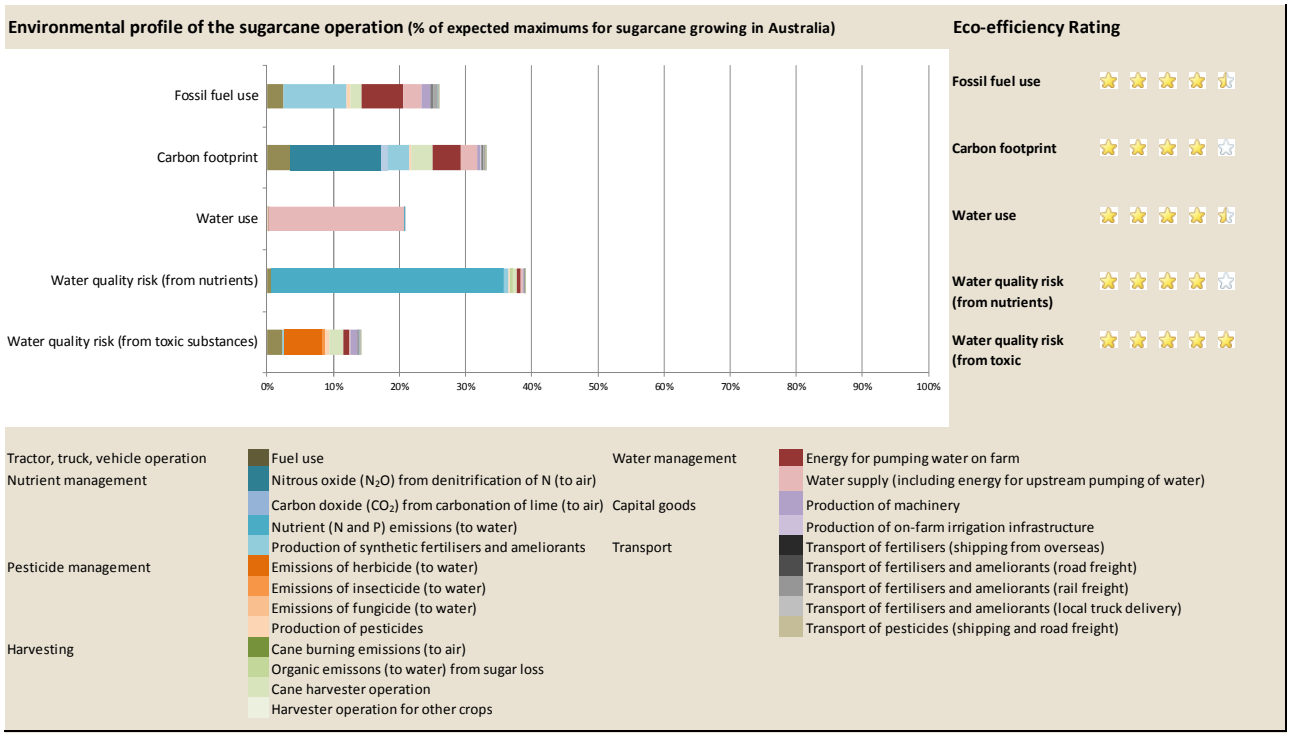


Figure 2 Example results generated by CaneLCA



Intended users

CaneLCA has been designed to be used by agricultural and extension advisors, who provide technical support to sugarcane producers. It may also find application with researchers, natural resource managers and policy officers of industry associations.

Quick guide to using CaneLCA

CaneLCA is a MS Excel workbook contains 10 worksheets, eight for data input, and two for presenting the outputs, as shown on the tool map in Figure 3.

First **ENTER** the required data into the WHITE cells of the data entry sheets (1-8):

- Sheet 1. Farm Details. Enter cropping areas and yields, so the tool can calculate overall farm production. Then list machinery and implements in service on the farm.
- Sheets 2-7. On each of these sheets, enter data about farm operations - soil work, nutrient and pest management, harvesting, and water management etc.
- Sheet 8. Emission Factors. This sheet summarised the default environmental emission factors applied by the tool. The user only needs to use this sheet if the default emission factors are to be changed.

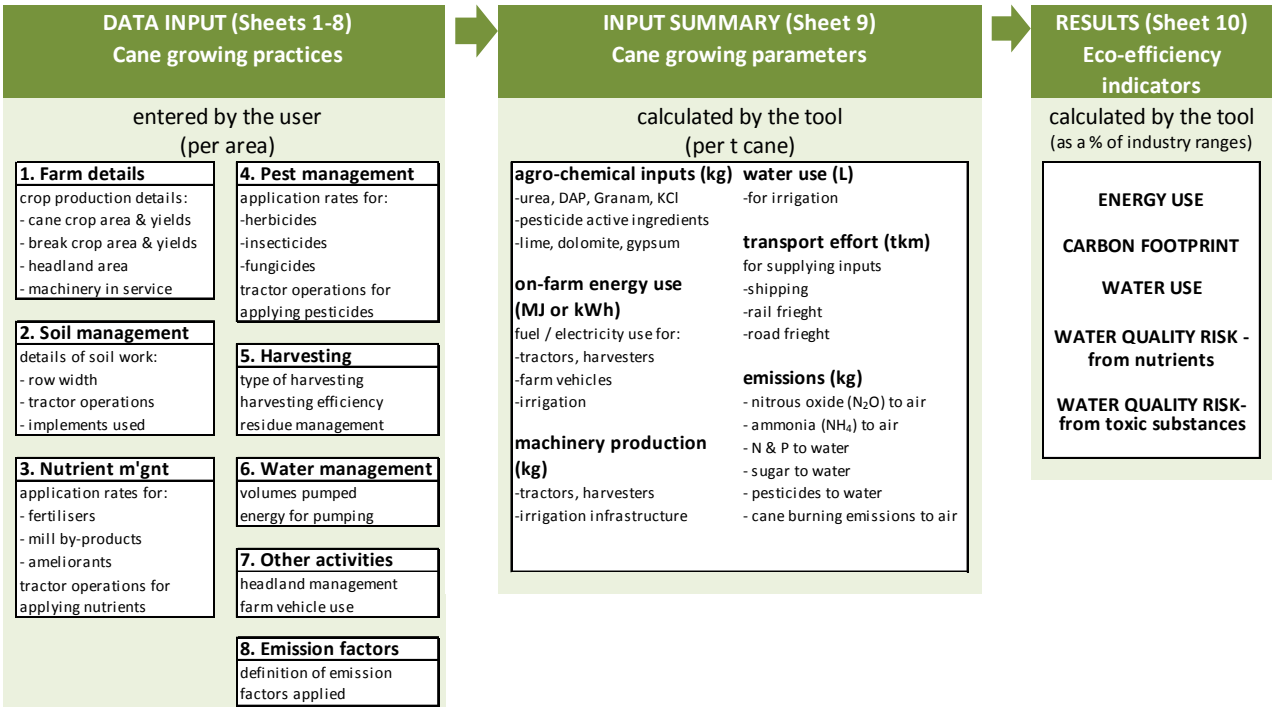
Then, **REVIEW** the outputs generated by the tool on sheets 9 and 10:

- Sheet 9. Input Summary. Review the summary of inputs and check for omissions and mistakes.
- Sheet 10. Results. Review the generated environmental profile and eco-efficiency ratings.

Finally, **INTERPRET** from the results:

- Sources of environmental impacts
- Relative eco-efficiency performance of the assessed farm, compared with industry ranges

Figure 3 CaneLCA Map



Users can start with a PRE-FILLED version for the region being assessed and modify the data to suit the scenario being assessed, or start with a BLANK version and enter data from scratch. PRE-FILLED versions can be obtained by contacting Marguerite Renouf (m.renouf@uq.edu.au).

When completed, Sheets 9 (Input Summary) and Sheet 10 (Results) can be easily printed as a record of the assessment. The results graph on Sheet 10 (Results) can also be exported into another document (MSWord or MSExcel) to enable the results from multiple assessments to be easily compared.

Note about using results from CaneLCA

CaneLCA reports LCA results as an environmental profile with relative indicators of eco-efficiency performance. It does not report absolute environmental impacts results (per tonne of cane). Therefore, the outputs of CaneLCA cannot be used for external reporting. CaneLCA is designed for internal monitoring and comparison of cane growing practices. It is not appropriate to use CaneLCA for comparing between different farms or regions, as the normalisation process used to generate the eco-efficiency results is broad and does not account for the different environmental conditions in different regions.

About this instruction manual

This manual contains detailed instructions for operating CaneLCA. Each section in the manual aligns with each worksheet of the CaneLCA tool. The CaneLCA tool also contains brief instructions as 'pop-up' comments that are revealed when the user scrolls over the relevant cell. Cells with instructions can be identified by the red triangle in the corner. The methods used within the tool are described in a separate document, titled Methods for CaneLCA Eco-efficiency Calculator, which can be obtained by contacting Marguerite Renouf (m.renouf@uq.edu.au).

Access to CaneLCA

Copies of the CaneLCA tool and the support documentation can be requested from Marguerite Renouf (m.renouf@uq.edu.au) or Peter Allsopp (PAllsopp@bses.com.au).

It is available for MS Excel 2010, as well as earlier versions of Excel (97-2003).

Support and feedback

If you experience difficulties using CaneLCA, please contact Marguerite Renouf (0478 220551, m.renouf@uq.edu.au), who can provide support over the phone or by email.

Alternatively, you can provide written feedback to the developers by emailing Marguerite Renouf (m.renouf@uq.edu.au) or Peter Allsopp (PAllsopp@bses.com.au).

INSTRUCTIONS

Before you start

Defining the sugarcane growing operation to be assessed

CaneLCA is designed to assess a sugarcane growing operation made up of up to seven (7) different production areas – areas under cane, areas under other crops (break crops) and other areas (fallow, headland, etc.) . Before starting an assessment, consider the cane growing operation to be assessed and the production areas within it. The user will need to define the areas to be included at the start of the assessment.

Working through the tool

Complete each of the data entry worksheets from Sheet 1 to Sheet 7. Sheet 1 (Farm Details) must be completed first to define production areas, and then Sheets 2 to 7 can be completed in any order. Sheet 8 (Emissions Factors) only needs to be completed if the user wishes to modify the default environmental emissions factors applied by the tool.

Sheet 9 (Summary of Inputs) and Sheet 10 (Results) can be accessed and reviewed at any time during the assessment. However the outputs will not be final until all the relevant data is entered into Sheets 1-7.

Pop-up instructions

The tool contains some instructions as 'pop-up' comments that are revealed when the user scrolls over the relevant cell. Cells with instructions can be identified by the red triangle in the corner.

Entering data

The data and information required by the tool is entered into the WHITE cells of the data entry sheets (Sheets 1-7). Information and data can be entered either by using the drop-down menus provided, or by entering a value directly. Click on the white cells to see if there is a drop-down menu for that item, which will appear as an arrow-box to the right of the cell. If there is no drop-down menu, then enter a value directly. The shaded cells are fields where the tool automatically enters calculated results, and are protected.

Data entry

Sheet 1 - Farm details

1.1 Identifiers

In this section enter the name of the farming operation to be assessed, and select the relevant region from the drop-down menu. Fields are also provided to record the assessor's name and organisation, assessment date, scenario identifier and comments.

1.2 Cane production details

Details of sugarcane crop rotation are entered, so the tool can calculate overall cane production.

First define the typical growing period for the scenario assessed, by selecting either 1-year or 2-years from the drop-down menu. In Queensland, cane crops are typically grown for 1 year before harvesting, hence the growing period will be 1 year. In NSW, part of the crop may be harvested after the first year and the remainder 'stood over' into a second year, in which case a 2-year growing period should be selected. The selection of a 1-year or 2-year growing period defines the timeframe of the assessment. If a 1-year growing period is selected, then the tool will calculate environmental impacts per tonne of cane based on cane production over a 1-year period. Similarly, if a 2-year growing period is selected environmental impacts will be calculated based on cane production over a 2-year period. This allows for stand-over cane to be included as a crop class in the assessment. Standover longer than 2 years cannot be included. Data entered into subsequent sheets should be for the specified growing period.

In the tables, select the type of plant cane and ratoon cane crops present on the assessed farm (Table 1), and enter their respective areas and yields. The tool uses this information to calculate the average yields and total cane production. See Figure 4 for an example.

1.2 Areas to be assessed

In this section, the areas to be included in the assessment are defined. See Figure 5 for an example.

The tool allows for up to seven (7) different production areas – areas under cane, areas under other crops and other areas (fallow, headland, etc.). These area descriptors will be used in the other data entry sheets, so the user can describe the practices against each of the defined areas.

Details of the areas under cane are automatically populated from the data entered in Section 1.2. However an appropriate descriptor for the plant and ratoon cane crops needs to be selected.

Details of other crops and other areas need to be entered – type, area and yield (where relevant). For other crops , also enter their fate (either harvested or green manure) and the extent to which they supports cane production. This refers to the fixation of nitrogen by break crops that it utilised by subsequent cane crops. The % value entered represents the percentage of impacts from growing the break crop that will be

assigned to cane production. If the entire crop is turned in as green manure, then the value should be 100%. If the crop is harvested, leaving only residue then a good estimate is 50%.

Table 1 Crop classes

Plant cane crops	Ratoon cane crops	Break / interrow crops	Other areas
Plant cane-plough out-replant (1 yr)	Ratoons (1 yr)	Sorghum	Bare fallow
Plant cane-plough out-replant (2 yr)	Ratoons (2 yr)	Pulse	Pasture fallow
Plant cane-following fallow (1yr)	Ratoon 1 (1 yr)	Peanut	Headland
Plant cane-following fallow (2yr)	Ratoon 2 (1 yr)	Soybean	Riparian strip
Plant cane-following break crop (1yr)	Ratoon 3 (1 yr)	Legume	Farm forestry
Plant cane-following break crop (2yr)	Old ratoons (1 yr)		
	Ratoon 1 (2 yr)		
	Ratoon 2 (2 yr)		
	Ratoon 3 (2 yr)		
	Old ratoons (2 yr)		

Figure 4 Example of cane production details

1.2 Production details

Growing period	1 year

Plant cane crops harvested in the growing period			
Plant cane	Area (ha)	Yield (t cane/ha)	Production (t harvested cane)
Plant cane (following break crop) (1yr)	20	110	2,200
Plant cane (1 yr)	20	110.0	2,200
Plant cane (2 yr)			
Total for plant cane	20	110.0	2,200

Ratoon crops harvested in the growing period			
Ratoon cane	Area (ha)	Yield (t cane/ha)	Production (t harvested cane)
Ratoon 1 (1 yr)	20	100	2,000
Ratoon 2 (1 yr)	20	95	1,900
Ratoon 3 (1 yr)	20	90	1,800
Old ratoons (1 yr)	20	80	1,600
Ratoons (1 yr)	80	91.3	7,300
Ratoons (2 yr)			
Total for ratoons	80	91.3	7,300

Figure 5 Example of areas to be assessed

1.3 Areas to be assessed

Areas under cane	Type	Area (ha)	Yield (t/ha)	Cane production (t)
Plant cane	Plant cane (following break crop) (1yr)	20	110	2,200
Ratoon cane	Ratoons (1 yr)	80	91	7,300
TOTAL		**100**		**9,500**

Areas under other crops	Type	Area (ha)	Yield (t/ha)	Fate	Allocation to cane (%)
Break crop	Legume	20	2.5	Green manure	100%
Interrow crop					

Other areas	Type	Area (ha)
Fallow		
Headland	Headland	5
Other		

All area	**Total Farm Area (ha)**	**125**

1.3 Machinery and implements

In this section, the user generates a list of machinery and implements used on the assessed farm. These become the drop-down lists for selecting machinery and implements in the other worksheets. The entered information is also used to calculate the embodied impacts of producing these items. See Figure 5 for an example.

In the left-hand column of each table, enter a descriptor for each item of machinery or implement in service. Against each item enter the power rating (for machinery) or size (for implements), the number in service, and the expected life span. If you don't know the expected life span, leave blank and the tool will assume 20 years.

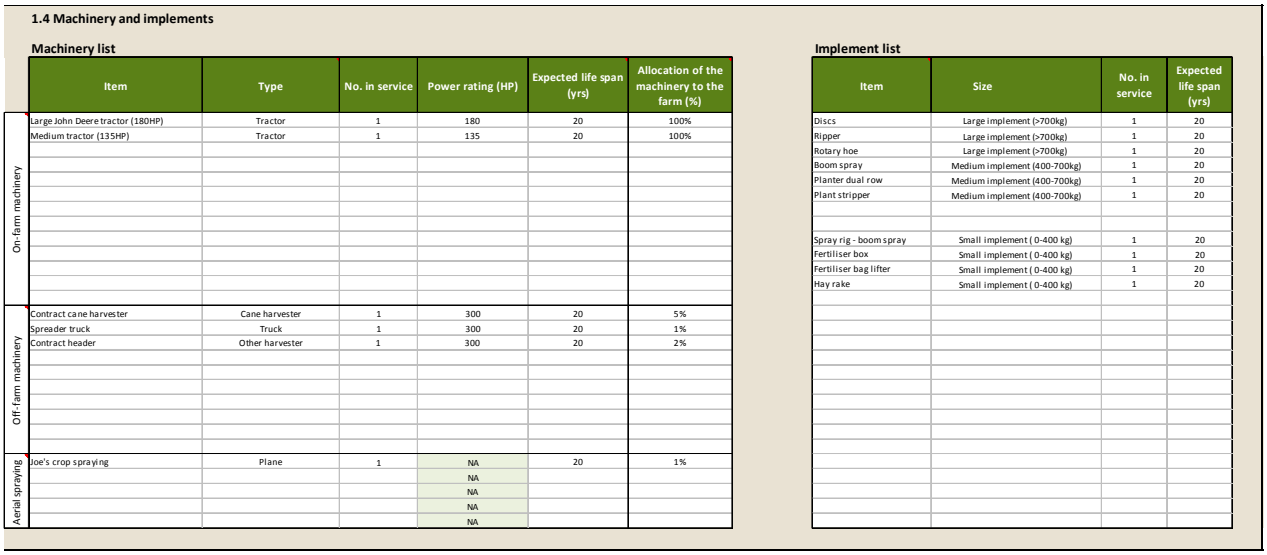
Machinery can include on-farm machinery, off-farm machinery and aerial spraying.

On-farm machinery refers to those owned and operated solely for use on the farm, including tractors, trucks, and harvesters. Do not list farm vehicles, motorbikes, quad-bikes or irrigation equipment, as these are accounted for in Section 7 - Other activities and Section 6 – Water management.

Off-farm machinery refers to those employed under contract, including contract harvesters, contract billeting planters, contract spraying, and truck used for spreading ameliorants. Do not list trucks used for delivering and spreading mill by-products and organic fertilisers, as these our outside the scope of the assessment. Aerial crop spraying services are listed separately in the last section.

For each machinery item, also indicate the percentage of the machinery's annual operation that is in service for the assessed farm, and that should be allocated to the farm.

Figure 6 Example of machinery and implement list



1.4 Machinery and implements

Machinery list

	Item	Type	No. in service	Power rating (HP)	Expected life span (yrs)	Allocation of the machinery to the farm (%)
On-farm machinery	Large John Deere tractor (180HP)	Tractor	1	180	20	100%
	Medium tractor (135HP)	Tractor	1	135	20	100%
Off-farm machinery	Contract cane harvester	Cane harvester	1	300	20	5%
	Spreader truck	Truck	1	300	20	1%
	Contract header	Other harvester	1	300	20	2%
Aerial spraying	Joe's crop spraying	Plane	1	NA	20	1%
				NA		
				NA		
				NA		
				NA		

Implement list

Item	Size	No. in service	Expected life span (yrs)
Discs	Large implement (>700kg)	1	20
Ripper	Large implement (>700kg)	1	20
Rotary hoe	Large implement (>700kg)	1	20
Boom spray	Medium implement (400-700kg)	1	20
Planter dual row	Medium implement (400-700kg)	1	20
Plant stripper	Medium implement (400-700kg)	1	20
Spray rig - boom spray	Small implement (0-400 kg)	1	20
Fertiliser box	Small implement (0-400 kg)	1	20
Fertiliser bag lifter	Small implement (0-400 kg)	1	20
Hay rake	Small implement (0-400 kg)	1	20

Sheet 2 - Soil work

In this sheet, machinery operations for soil work are entered, so the tool can calculate fuel use and fuel combustion emissions for soil work. The soil work activities included here are mostly associated with crop establishment (tillage, bed forming, planting, etc.), but also weed control.

2.1 Practices

Provide a descriptor of the soil management practices for the assessed scenario, by either selecting from the drop-down menu options or entering your own descriptor.

2.2 Machinery operations for soil work

First select the type of fuel used (diesel or bio-diesel).

Then enter all the machinery operations that take place for soil work across all areas. It helps to enter the operations sequentially in the order they occur from ground preparation, through to planting and crop maintenance. See Figure 5 for an example.

Do not include machinery operations for:

- applying nutrients (enter these in Sheet 3 - Nutrient Management);
- spray out and applying pesticides (enter these in Sheet 4 -Pest Management);
- harvesting, including for seed cane (enter these in Sheet 5 – Harvesting);
- headland slashing (enter these in Sheet 7 – Other activities);
- land levelling and drainage works occur if they occur infrequently.

For each operation, select from the drop-down menus the purpose for and type of operation (Table 2), and the machinery and implements used (user's own machinery and implement list). If the required machinery

or implement items are not on the drop-down list, then add them to the user's machinery list in section 1.4 on Sheet 1-Farm Details.

Enter the load factor, the number of passes, the width treated by the implement, and the speed for each operation. At this point, an estimate of fuel use will be generated. The user can enter their own estimate for the rate of fuel use (L/ha), if available, which will overwrite the tool's estimates. See an example in Figure 7.

Table 2 Soil work operations

Purpose	Type of operation		
Ground preparation	Bed forming	Grubbing	Rolling
Cane planting	Billet cutting	Harrowing	Rotary hoeing
Post cane planting	Billet haulout	Hilling up	Row marking
Break crop planting	Billet planting	Inter-row cultivate	Row profile shaping
Ratoon management	Centre busting	Land levelling	Scarifying
Headland management	Combine planter	Marking out	Scarifying
	Contract billet planting	Mole draining	Seed planting
	Cutting away	Other	Spray out
	Direct drill	Ploughing	Tillering
	Discing	Raking	Trash incorporation
	Break crop incorporation	Raking following a burn	Weed raking
	Filling in	Ripping	Zonal rotary hoeing

Figure 7 Example of machinery operations for soil work

2.1 Practices

Soil management practices	Best practice	

2.2 Machinery operations for soil work

Fuel type	% used
Diesel	100%
Biodiesel	0%
Total must be 100%	100%

Row spacing (m)	1.5

Calculator to convert from feet (ft) to meters (m)	
ft	m
1	0.309

Area descriptor	Purpose	Type of operation	Machinery used	Implement used	Load factor (Heavy =1.2, Normal=1.0, Light=0.8)	No. of passes	Width treated by implement (m)	No. of rows treated by implement	Speed (km/hr)	Rate of fuel use (L/ha)		Fuel use (L/operation)
										Tool's estimate	User's estimate	
Plant cane	Ground preparation	Discing	Medium tractor (135HP)	Discs	1.2	1.0	1.5	1.0	10.0	20		405
Plant cane	Ground preparation	Ripping	Medium tractor (135HP)	Ripper	1.2	1.0	1.5	1.0	8.0	25		506
Plant cane	Ground preparation	Zonal rotary hoeing	Medium tractor (135HP)	Rotary hoe	1.2	1.0	1.5	1.0	4.0	51		1,013
Plant cane	Cane planting	Cane planting	Medium tractor (135HP)	Planter dual row	1.0	1.0	1.5	1.0	2.5	68		1,350
Plant cane	Cane planting	Cane planting	Medium tractor (135HP)	Plant stripper	0.9	1.0	1.5	1.0	5.0	30		608
Plant cane	Cane planting	Cane planting	Medium tractor (135HP)	Plant cutter	0.9	1.0	1.5	1.0	2.0	76		1,519
Plant cane	Post cane planting	Rolling	Small tractor (100HP)	Roller	0.9	1.0	1.5	1.0	10.0	11		225
Ratoon cane	Ratoon management	Raking	Small tractor (100HP)	Hay rake	0.8	1.0	1.0	0.7	7.0	21		1,714
Break crop	Break crop planting	Seed planting	Small tractor (100HP)	Seed drill	1.1	1.0	3.0	2.0	8.0	9		172
											Total fuel use (L)	7,511

Sheet 3 - Nutrient Management

In this sheet, information is collected about the nutrient products (fertilisers, mill by-products and ameliorants) applied to each production area, so the tool can calculate:

- the embodied impacts of producing nutrient products;
- the impacts of transporting nutrient products from manufacturers to the farm;
- the fuel use for applying them; and
- the nutrients released to the environment (air and water).

3.1 Practices

First provide a descriptor of the nutrient management practices for the assessed scenario by either selecting from the drop-down menu options or entering your own descriptor.

3.2 Synthetic fertilisers, ameliorants and minerals applied

Enter the nutrient product(s) applied into the appropriate table depending on whether they are mill by-products / organic fertilisers, synthetic fertilizers or ameliorants. See an example in Figure 8.

For mill by-products and ameliorants the products can be selected from the drop-down menu (Table 3), and for synthetic fertilisers the name of the fertiliser products is entered directly.

For each nutrient product, enter the number of applications and the application rate so the tool can calculate the total amount of product applied to each area over the growing period. If the nutrient product is applied to only part of an area, then enter this area. If left blank the tool will assume it is applied to the whole area.

For mill by-products / organic fertilisers and synthetic fertilisers, enter the nutrient content (%) so the tool can calculate the amount of nutrients (N,P,K and S) applied. Also enter an estimate of how much of the product remains on the soil surface after application (%). This value will be 0% if applied sub-surface, and 100% if surface-applied. For mill by-products / organic fertilisers that are spread and then turned it, this may be around 10%. This factor is used by the tool to estimate how much of applied ammonia-N is exposed to volatilization. It does not apply for mineral products.

The user can elect to enter the crop stage at which the nutrient products are applied. This is optional, and is only provided for information.

For synthetic fertilisers and ameliorants, also enter information about transport for supplying nutrient products from the retailer to the farm, i.e. the delivery distance and the type of truck used.

The quantities of the nutrients products applied and the resulting nutrient application rates, generated by the tool, are summarised in the summary tables. See an example in Figure 9. Review these quantities and make any required adjustments to the entered values, as necessary.

Table 3 Mill by-products, organic fertilisers and ameliorants

Mill by-products / organic fertilisers	Ameliorants
Dunder (with added NPKS)	Lime
Dunder (without added NPKS)	Dolomite
Mill mud	Gypsum
Ash	
Mill mud/ash mix	
Compost	
Chicken manure	

3.5 Machinery operations for applying mill by-products / organic fertilisers, synthetic fertilisers and ameliorants

First select the type of fuel used (diesel or bio-diesel).

Then enter all the machinery operations for applying nutrient products. See an example in Figure 10.

If nutrients are applied as part of soil work for crop establishment (for example, sub-surface placement during planting), and have already been listed in Sheet 2-Soil Work, they do not need to be re-entered here.

For each operation, select from the drop-down menus the type of machinery and implements used (user's own machinery and implement list). If the required machinery or implement items are not on the drop-down list, then add them to the user's machinery list in section 1.4 on Sheet 1-Farm Details.

Then enter the load factor, the number of passes, the width treated by the implement, and the speed.

Review the 'tool's estimate of fuel use' for each operation (L), and adjust the entered values if necessary. The user's own estimates of fuel use can be entered if known, which will overwrite the tool's estimates

Figure 8 Examples of nutrient products applied

3.2 Nutrient products applied

Mill by-products / organic fertilisers

Area	Product	Application amount				Nutrient content (%)				Application method	
		Area treated (ha) OPTIONAL	No. of applications	Rate (m^3/ha or t/ha)	Total (m^3 or t)	N	P	K	S	% surface applied	Crop stage OPTIONAL
Plant cane	Dunder (with added NPKS)	20	1	1.5	3,465	7.7%	0.0%	2.6%	0.5%	0%	At Planting
Ratoon cane	Dunder (with added NPKS)	80	1	1.2	8,870	7.7%	0.0%	2.6%	0.5%	0%	Side dressing

Nutrient contents of mill by-products / organic fertilisers (%)				
Product	N	P	K	S
Dunder (without added NPKS)	0.50	0.05	2.60	0.30
Mill mud	3.40	2.34	0.88	0.53
Ash	0.59	0.71	2.58	0.17
Mill mud / ash mix	1.96	1.51	1.64	0.33
Compost				
Chicken manure				

Synthetic fertilisers

Area	Product	Application amount				Nutrient content (% wt/wt or wt/vol)				Application method		Delivery from retailer to farm		
		Area treated (ha) OPTIONAL	No. of applications	Rate (kg/ha or L/ha)	Total applied (kg or L)	N	P	K	S	% surface applied	Crop stage OPTIONAL	Distance (km)	Truck used	Transport (t.km)
Plant cane	Plant mix	20	1	150	600	20.0%	7.0%	20.0%	5.0%	10%	At Planting	50	Truck (5t load)	30,000
Ratoon cane	Ratoon mix	40	1	300	3,000	25.0%	7.0%	20.0%	5.0%	10%	Side dressing	50	Truck (5t load)	150,000

Ameliorants

Area	Product	Application amount				Delivery from retailer to farm		
		Area treated (ha) OPTIONAL	No. of applications	Rate (t/ha)	Total (t)	Distance (km)	Truck used	Transport (t.km)
Plant cane	Lime	10	1	2.5	25	50	Truck (25t load)	1,250

Figure 9 Summary of nutrient products applied

Summary of nutrient products applied													
Area	**Mill by-products / organic fertilisers (m^3)**						**Synthetic fertilisers (kg)**				**Ameliorants (t)**		
	Dunder	Mill mud	Ash	Mill mud/ash mix	Compost	Chicken manure	Urea	Diammonium phosphate (DAP)	Potassium chloride (KCl)	Ammonium sulphate (Granam)	Lime	Dolomite	Gypsum
Plant cane	3,465						5,567	895	1,146	620	25		
Ratoon cane	8,870						19,584	3,578	4,584	2,478			
Break crop													
Interrow crop													
Fallow													
Headland													
Other													
Totals	**12,335**						**25,151**	**4,473**	**5,730**	**3,098**	**25**		

Summary of nutrients applied													
Area	Nitrogen applied (kg/ha)			**Total N available (kg)**	Phosphorus applied (kg/ha)		**Total P available (kg)**	Potassium applied (kg/ha)		**Total K available (kg)**	Sulphur applied (kg/ha)		**Total S available (kg)**
	Mill by-products	Synthetic fertilisers	Crop residues		Mill by-products	Synthetic fertilisers		Mill by-products	Synthetic fertilisers		Mill by-products	Synthetic fertilisers	
Plant cane	115.5	30.0	55.0	4,010		10.5	210	39.0	30.0	1,380	7.8	7.5	306
Ratoon cane	92.4	37.5	45.6	14,042		10.5	840	31.2	30.0	4,896	6.0	7.5	1,080
Break crop			69.6	2,392									
Interrow crop													
Fallow													
Headland													
Other													
Totals				**20,444**			**1,050**			**6,276**			**1,386**

Figure 10 Example of machinery operations for nutrient application

3.3 Machinery operations for applying nutrients

Fuel type	% used
Diesel	100%
Biodiesel	0%
Total must be 100%	100%

	Area descriptor	Nutrient product applied	Machinery used	Implement used	Load factor (Heavy =1.2, Normal=1.0, Light=0.8)	No. of passes	Width treated by implement (m)	No. of rows treated by implement	Speed (km/hr)	Rate of fuel use (L/ha) Tool's estimate	Rate of fuel use (L/ha) User's estimate	Fuel use (L/operation)
Synthetic fertilisers	Plant cane	Plant mix	Small tractor (100HP)	Fertiliser box	0.8	1.0	3.0	2.0	8.0	6		125
	Ratoon cane	Ratoon mix	Small tractor (100HP)	Fertiliser box	0.8	1.0	3.0	2.0	8.0	6		500
Ameliorants	Plant cane	Lime	Spreader truck		1.0	1.0	30.0	20.0	10.0	2		38
											Total fuel use (L)	663

Sheet 4 - Pest Management

In this sheet, information is collected about the pesticides applied to each area so the tool can calculate:

- the embodied impacts of producing pesticide products;
- the impacts of transporting pesticide products from manufacturers to the farm;
- the fuel use for applying them; and
- the pesticide active ingredients that may be released to the environment (to water).

4.1 Practices

First provide a descriptor of the pest management practices for the assessed scenario, by either selecting from the drop-down menu options or entering your own descriptor.

4.2 Pesticides applied

Enter the names of the pesticide products applied, into the appropriate section depending on whether they are herbicides, insecticides or fungicide. See an example in Figure 11.

As numerous applications are common, especially for herbicides, data entry can be repetitive and the table can fill up quickly. To avoid this, try to combine multiple applications of the same product into a single entry, by using the 'number of applications' column.

For each pesticide product, enter the number of applications, and the application rate of pesticide product (kg/ha or L/ha). If the pesticide product is applied to only part of an area, then enter this area. If left blank the tool will assume it is applied to the whole area. The time of application can also be selected from drop-down menu (Table 4), but is optional and only entered for information.

Table 4 Time of pesticide application

Cane knockout	Stooling
In planting	Stooling out of hand
Spike	Out of hand
Pre-emergent	Headland management
Post-emergent	Not applicable

For each pesticide product, select the constituent active ingredient(s) (AI) from the drop down menu (Table 5), and enter the content (g/L or g/kg), so the tool can calculate the total amount of pesticide active ingredients applied to each area. There will usually be only one or two active ingredients. If there are more only enter to the two main ingredients.

To find out the active ingredients in pesticides products, consult the label information, the material and safety data sheet (MSDS), or the Australian Pesticides and Veterinary Medicines Authority website (www.apvma.gov.au) (see Figure 12).

Table 5 Pesticide active ingredients

Herbicides		Insecticides	Fungicides
2,4 D	Isoxaflutole	Aldicarb	Mercury (Memc)
2,4 D Amine	MCPA	Carbaryl	Propiconazole
Ametryn	Metolachlor	Chlorpyrifos	
Asulam	Metribuzin	Fipronil	
Atrazine	MSMA	Imidacloprid	
Diuron	Paraquat		
Fluroxypyr	Pendimethalin		
Glyphosate	Picloram		
Hexazinone	Trifluralin		

4.3 Machinery operations for pest management

First select the type of fuel used (diesel or bio-diesel). Then enter all the machinery operations that take place for applying pesticide products for all areas. See an example in Figure 13.

If pesticides are applied as part of soil work for crop establishment (for example, sub-surface placement during planting), and have already been listed in Sheet 2-Soil Work, they do not need to be re-entered here.

The application method can also be selected from drop-down menu (Table 6Table 4), but is optional and only entered for information

For each operation, select from the drop-down menus the type of machinery and implements used (user's own machinery and implement list). If the required machinery or implement items are not on the drop-down list, then add them to the user's machinery list in section 1.4 on Sheet 1-Farm Details.

Then enter the load factor, the number of passes, the width treated by the implement, and the speed.

Review the 'tool's estimate of fuel use' for each operation (L), and adjust the entered values if necessary. The user's own estimates of fuel use can be entered if known, which will overwrite the tool's estimate.

Table 6 Pesticide application method

Mechanical	Droppers	Aerial spray
Boom spray	Hooded spray	High clearance spray
Band spray	Spot spray	Irvin leg

Figure 11 Example of pesticides applied

4.2 Pesticides applied

Herbicides

							Active Ingredient 1				Active Ingredient 2			
Area descriptor	Name of herbicide product	Time of application	Area treated (ha) OPTIONAL	No. of applications	Application rate of herbicide product (L/ha or kg/ha)	Units (kg/ha or L/ha)	Active ingredient (AI 1)	AI content (g/L or g/kg)	Application rate (kg/ha)	Total applied (kg AI)	Active ingredient (AI 2)	AI content (g/L or g/kg)	Application rate (kg/ha)	Total applied (kg AI)
Plant cane	StompXtra	Pre-emergent	20	1	3	L/ha	Pendimethalin	455	1.37	27.3				
Plant cane	Atradex	Pre-emergent	20	1	3	kg/ha	Atrazine	900	2.70	108.0				
Plant cane	Gramoxone	Pre-emergent	20	2	1	L/ha	Paraquat	250	0.25	10.0				
Plant cane	Gesapax Combi	Stooling out of hand	20	1	6	L/ha	Ametryn	250	1.50	30.0	Atrazine	250	1.5	30.0
Ratoon cane	2,4,D	Stooling out of hand	80	1	1	L/ha	2,4 D	620	0.62	49.6				
Ratoon cane	Starane	Stooling out of hand	80	1	0.78	L/ha	Fluroxypyr	333	0.26	20.8				

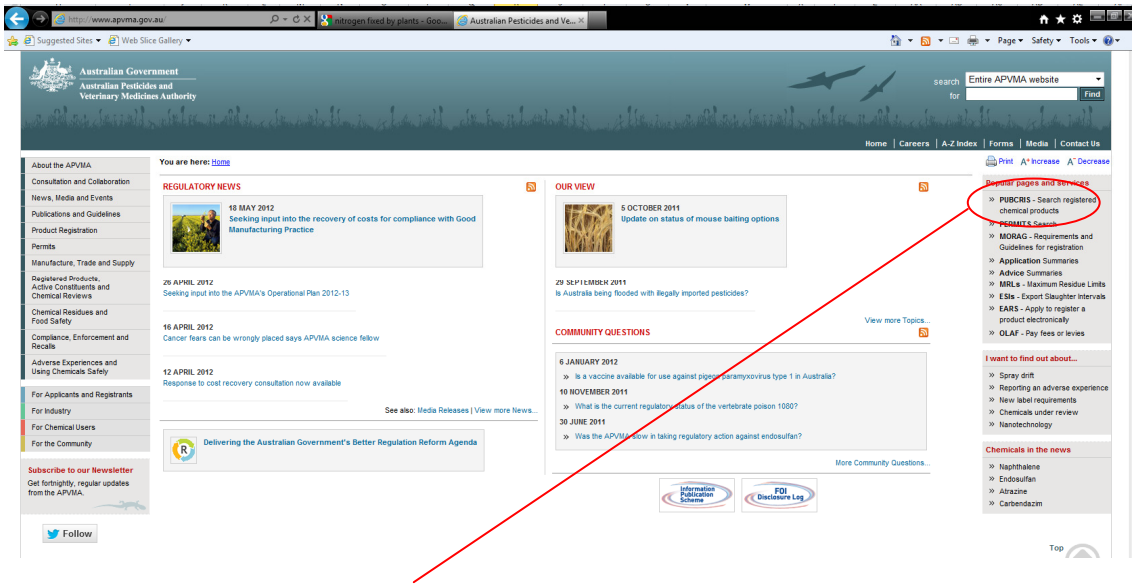
Insecticides

							Active Ingredient 1				Active Ingredient 2			
Area descriptor	Name of insecticide product	Time of application	Area treated (ha) OPTIONAL	No. of applications	Application rate of insecticide product (L/ha or kg/ha)	Units (kg/ha or L/ha)	Active ingredient (AI 1)	AI content (g/L or g/kg)	Application rate (kg/ha)	Total applied (kg AI)	Active ingredient (AI 2)	AI content (g/L or g/kg)	Application rate (kg/ha)	Total applied (kg AI)
Plant cane	Suscon Maxi	Stooling out of hand	20	1	15	kg/ha	Imidacloprid	50	0.75	15.0				
Plant cane	Regent	In planting	20	1	0.375	L/ha	Fipronil	200	0.08	1.5				

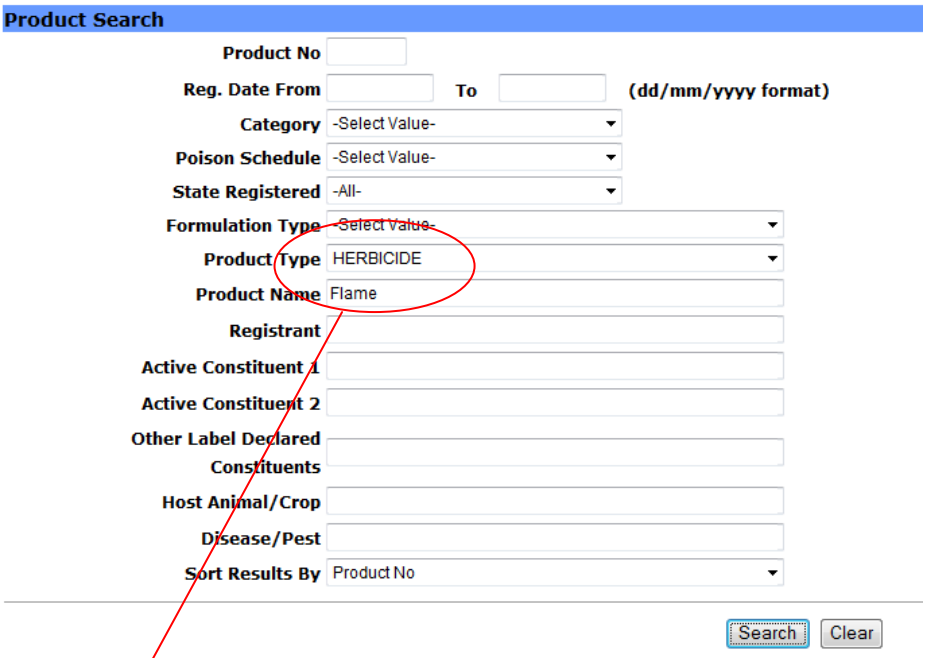
Fungicides

							Active Ingredient 1				Active Ingredient 2			
Area descriptor	Name of fungicide product	Time of application	Area treated (ha) OPTIONAL	No. of applications	Application rate of fungicide product (L/ha or kg/ha)	Units (kg/ha or L/ha)	Active ingredient (AI 1)	AI content (g/L or g/kg)	Application rate (kg/ha)	Total applied (kg AI)	Active ingredient (AI 2)	AI content (g/L or g/kg)	Application rate (kg/ha)	Total applied (kg AI)
Plant cane	Tilt	In planting	20	1	0.1	L/ha	Propiconazole	250	0.03	0.5				

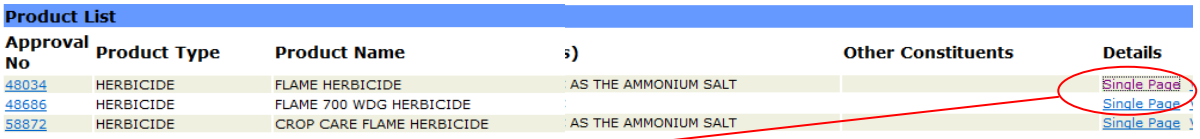
Figure 12 Identifying active ingredients from www.apvma.gov.au



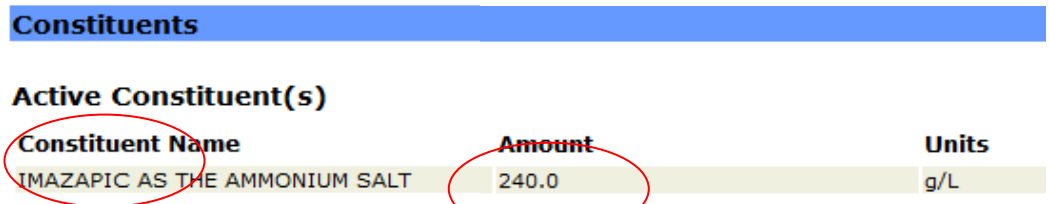
Click on "PUBCRIS – Search registered chemical products"



Type in type of product e.g. Herbicide and product name e.g. Flame and select search



Click on "Single page" of details



Name of the active ingredient in flame g/L of active ingredient

Figure 13 Example of machinery operations for applying pesticides

4.3 Machinery operations for pesticide management

Fuel type	% used
Diesel	100%
Biodiesel	0%
Total must be 100%	100%

Area descriptor	Pesticide product(s) applied	Method	Machinery used	Implement used	Load factor (Heavy =1.2, Normal=1.0, Light=0.8)	No. of passes	Width treated by implement (m)	Number of rows treated by implement	Speed (km/hr)	Rate of fuel use (L/ha)		Fuel use (L/operation)
										Tool's estimate	User's estimate	
Plant cane	Herbicide	Boom spray	Small tractor (100HP)	Boom spray	0.8	1.0	9.5	6.3	8.0	2		39
Plant cane	Herbicide	Boom spray	Small tractor (100HP)	Boom spray	0.8	1.0	9.5	6.3	8.0	11		211
											Total fuel use (L)	250

Sheet 5 - Harvesting

In this sheet, information is collected about harvesting so the tool can calculate:

- the fuel use and fuel combustion emissions for the harvest and haulout of cane and other crops;
- the sugar lost during harvesting; and
- emissions from the burning of harvest residues.

5.1 Harvest and haulout operations

First select the type of fuel used (diesel or bio-diesel). Then enter the harvester operations that take place for all area, in the appropriate section of the table depending on whether it is cane harvesting or other crop harvesting.

For each harvesting operation select the type of machinery used. If only part of an area is harvested, then enter this area. If left blank the tool will assume it the whole area is harvested.

Review the tool's estimate of fuel use for harvest and haulout (L/t crop). The user can enter their own estimate for the rate of fuel use (L/t), if available, which will overwrite the tool's estimates..

5.2 Cane harvester efficiency and sugar loss

In this section information about the factors that influence harvesting efficiency and sugar loss are entered so that tool can estimate the potential for sugar loss from the farm.

For each cane harvesting operation, select the harvester fan type (4' or 4.5'-5') and enter the fan speed.

Review the tool's estimate of in-field sugar loss from harvesting. The user's own estimates can be entered if know, which will overwrite the tool's estimate.

5.4 Fate of harvest residues

For each harvested area (cane and other crops), select the harvesting practice from the drop-down menu (Table 7). For unharvested areas select 'not applicable'. Then enter the percentage of the harvest residue that is removed, burnt pre-harvest, burnt post- harvest or retained in the field as trash. All entered percentages in each row need to add up to 100%.

Table 7 Type of harvesting

Green cane harvesting
Burnt cane harvesting
Whole cane harvesting
Other crop harvesting
Not applicable

Figure 14 Example of harvest and haulout operations

5.1 Harvest and haulout operations

Fuel type	% used
Diesel	100%
Biodiesel	0%
Total must be 100%	100%

Area descriptor	Area harvested (ha) OPTIONAL	Machinery used	Rate of fuel use for harvest and haulout (L/ t crop)		Fuel use (L/operation)
			Tool's estimate	User's estimate	
Plant cane		Contract cane harvester	1.04		2,284
Ratoon cane		Contract cane harvester	1.16		8,468
Break crop		Contract header			
Interrow crop					

5.2 Cane harvester efficiency and sugar loss (for green cane harvesting)

Area descriptor	Fan type	Fan speed (RPM)	Rate of in-field sugar loss during harvest (kg sugar/t cane)		In-field sugar loss (t sugar)	Wet harvest days (%)
			Tool's estimate	User's estimate		
Plant cane	4.5'-5' fan	500	0.10		0.2	20%
Ratoon cane	4.5'-5' fan	500	0.10		0.7	

5.3 Fate of harvest residues

Area descriptor	Crop type	Harvesting practice	Fate of harvest residues				Total (must equal 100%)
			% removed	% burnt pre-harvest	% burnt post-harvest	% retained in the field	
Plant cane	Plant cane (following break crop) (1yr)	Green cane harvesting		0%		100%	100%
Ratoon cane	Ratoons (1 yr)	Green cane harvesting		0%		100%	100%
Break crop	Legume	Not applicable	0%			100%	100%
Interrow crop							

Sheet 6 – Water management

In this sheet, information about irrigation and other water pumping activities (tailings water reclamation and dewatering) is collected so the tool can calculate:

- the quantities of water extracted from different sources; and
- the energy used for pumping water.

6.1 Irrigation practices

If irrigation is practiced on the farm, select the type of irrigation systems present on the farm, from the drop-down menu (Table 8), and enter the area serviced by each type of irrigation.

Table 8 Irrigation systems

Travelling gun	Centre Pivot
Furrow	Lateral move
Hand shift	Drip irrigation
Travelling boom	

6.2 Volumes of water pumped

Enter the water pumping activities that occur into the appropriate table depending on whether they are associated with irrigation or other water pumping activities (tailings water reclamation, dewatering). Pumping activities are not aligned to specific production areas, but to the water pumps or outlets. See an example in Figure 15.

Enter descriptors for the different pumps / outlets used to pump water. For each, select from the drop-down menus the type of irrigation or pumping activity it services (Table 8) and the water source (Table 9).

Table 9 Water sources

Water sources for irrigation	Water sources for other pumping
Dam	Tailings water
Ground	Surplus water
River	
Irrigation scheme	

For irrigation, use one of the following methods to enable the tool to estimate the volume of water applied over the growing period:

- If the water application rate (ML/ha) is known, then enter this along with the area irrigated.
- If the water application rate is NOT known, enter the flow rate delivered by the pump / outlet (ML/hr), the estimated pumping duration (hr/operation) and the number of operations over the growing period.

Either method will generate an estimate of the total water pumped for irrigation. Review this and adjust the entered values if necessary. The user's own estimates use can be entered if known, which will overwrite the tool's estimate.

Enter the total water applied to irrigate all crops - cane and other crops. But note in the last column the amount from the total that is applied to non-cane crops, so that the impacts of irrigation can be appropriately assigned to the break crop.

For other pumping operations (water reclamation and dewatering), the volume pumped is estimated using the second of the above methods.

In the 'Summary of water extraction and pumping', review the quantities of water estimated to be pumped from each sources and make any required adjustments to the entered values, as necessary.

6.3 Energy used for water pumping

In this section, the previously-specified details about water pumping are automatically populated into the table, and the user adds details so that the energy used for pumping can be calculated. See an example in Figure 16.

For each pump / outlet, select from the drop-down menu the energy source for pumping (electricity or fuel), then enter the head pressure and the overall pumping efficiency (%). Only include the pressure added at the farm, not pressure the water is received at.

If necessary, refer to the typical head pressures for different irrigation systems and water sources provided in the sheet. The pumping efficiency refers to the overall efficiency of pumping (of the pump and motor combined). Pumping efficiency is typically 50-70% for electric pumps & 25-30% for diesel pumps.

Review the 'tool's estimate of pumping energy', and enter the user's own estimates if known, which will overwrite the tool's estimates.

In the 'Summary of energy use for pumping', review the total energy use across all areas and make any adjustments to the entered values, as necessary.

Figure 15 Example of volumes of water pumped

6.2 Volumes of water pumped

Irrigation

			If application rate (ML/ha) IS KNOWN, use these columns to estimate water applied.			If application rate IS NOT KNOWN, use these columns to estimate water applied.					
Pump / outlet descriptor	Type of irrigation	Water source	Area irrigated (ha)	Application rate (ML/ha)	Tool's estimate (ML)	Pumping rate (ML/hr)	Pumping duration (hr/ operation)	No. of pumping operations	Tool's estimate (ML)	User's estimate of volume applied (ML) OPTIONAL	Volume applied to non-cane crops (ML)
Pump 1	Furrow	Irrigation scheme	80.0	3.5	280						
Pump 2	Hand shift	Dam	20.0	3.5	70						70.0

Other water pumping operations

Pump / outlet descriptor	Pumping activity	Water source	Pumping rate (ML/hr)	Pumping duration (hr/ operation)	No. of pumping operations	Tool's estimate of volume pumped (ML)	User's estimate of total volume pumped (ML)
Pump 3	Water reclamation	Tailings water	1.5	12	3	54	

	Summary of water extraction and pumping		
	Water source	Water pumped (ML) (total)	Water pumped (ML) (allocated to cane)
Irrigation	Dam	70	
	Ground water		
	River		
	Irrigation scheme	280	280
	Water use for irrigation	**350**	**280**
Other	Water reclamation	54	
	Dawatering		
	Other water pumping	**54**	

Figure 16 Example of energy for water pumping

6.3 Energy use for water pumping

Fuel type	% used
Diesel	100%
Biodiesel	0%
Total must be 100%	100%

	Descriptor of pumping operation	Volume pumped (ML)	Energy source for pump (if pressured added at the farm)	Head pressure (m)	Pumping efficiency (%)	Tool's estimate of pumping energy (L or kWh)	Units	User's estimate of energy use (L or kWh) OPTIONAL
Irrigation	Furrow	280	Electricity	10.0	60%	12,717	kWh	
	Hand shift	70	Fuel	80.0	30%	4,819	L	
Other	Water reclamation	54						

Tool to convert units of pressure (from psi to meters (m))		
psi	kPa	m
30	207	20.7

Typical head pressures for irrigation systems:

- Furrow (river) - 10m
- Furrow (bore) - 45m
- Centre pivot / linear move (river) - 40m
- Centre pivot / linear move (bore) - 70m
- Overhead spray (river) - 55m
- Overhead spray (bore) - 65m
- Traveller, medium pressure (river) - 85m
- Traveller, medium pressure (bore) - 90m
- Traveller, high pressure - 120m
- Drip - 50m

Summary of energy use for water management			
Type of fuel	Energy used for irrigation (total)	Energy used for irrigation (allocated to cane)	Energy used for other pumping
Diesel (L)	4,819	4,819	
Electricity (kWh)	12,717	12,717	

Sheet 7 - Other activities

In this sheet, information is collected about headland slashing and farm vehicle use.

7.1 Headland slashing and management

After specifying the type of fuel used for headland slashing, enter the area slashed, the number of times slashed over the growing period, and the operating rate of the slasher. Then select from the drop-down menus the type of machinery and implement used.

If the required machinery or implement items are not on the drop-down list, then add them to the user's machinery list in section 1.4 on Sheet 1-Farm Detail.

7.2 Farm vehicle use

After specifying the type of fuel used in farm vehicles, select from the drop-down menu the type of farm vehicle(s) used and enter the distance travelled over the growing period.

Sheet 8 – Emission factors

This section lists the default emission factors (EF) that are used by the tool to estimate on-farm emissions to the environment (Figure 18).

Wherever possible, recognised and published EFs have been used. However the user can overwrite these values by entering values more relevant to the scenario being assessed.

.

Figure 17 Example of headland slashing and farm vehicle use

7.1 Headland slashing and management

Fuel type	% used
Diesel	100%
Biodiesel	
Total must be 100%	100%

Area treated (ha)	Machinery used	Implement used	Load factor (Heavy =1.2, Normal=1.0, Light=0.8)	No. of times treated over growing period	Operating rate (ha/hr)	Rate of fuel use (L/ha)	
						Tool's estimate	User's estimate
5	Small tractor (100HP)	Slasher	0.8	4	0.25	1,200	

7.2 Farm vehicle use

Fuel type used for diesel vehicles	% used	Fuel type used for petrol vehicles	% used
Diesel	100%	Petrol	100%
Biodiesel	0%	Bioethanol	0%
Total must be 100%	100%	Total must be 100%	100%

Farm vehicle	Distance travelled over growing period (km)	Vehicle fuel efficiency (L/100km)		Fuel use (L)
		Tool's estimate	User's estimate	
Motor bike or quad	500	8.0	20.0	100
Diesel vehicle (2WD or 4WD)	10,000	11.5	15.0	1,500
			Diesel vehicles	1,500
			Petrol vehicles	100
			Total	1,600

Figure 18 Default environmental emission factors

8.1 Environmental emission factors used in the assessment

	Species lost to the environment	Emission factors (EF) used in the assessment			
		Default EF	Unit	Source	User's EF
Emissions to air	Nitrous oxide (N2O) from direct denitrification of applied nitrogen (N)	0.0125	kg N2O-N/kg N applied	DCCEE, 2010	
	Nitrous oxide (N2O) from indirect denitrification of redeposited nitrogen (NH3 and NOx)	0.0100	kg N2O-N/kg N redeposited	DCCEE, 2010	
	Nitrous oxide (N2O) from indirect denitrification of nitrogen lost through leaching and runoff	0.0125	kg N2O-N/kg N leached/ ruoff	DCCEE, 2010	
	Ammonia (NH_3) from volatilisation of fertiliser-N surface-applied to bare soil	0.1313	kg N/kg N surface-applied	Chapman, et al., 1995	
	Ammonia (NH_3) from volatilisation of fertiliser-N surface-applied to trash blanketed soil	0.2313	kg N/kg N surface-applied	Chapman, et al., 1995	
	Ammonia (NH_3) from volatilisation of dunder-N surface-applied to bare soil	0.0875	kg N/kg N surface-applied	Chapman, et al., 1995	
	Ammonia (NH_3) from volatilisation of dunder-N surface-applied to trash blanketed soil	0.1625	kg N/kg N surface-applied	Chapman, et al., 1995	
	CO2 from carbonation of limestone (CaCO3)	0.3960	kg CO2/kg limestone applied	DCCEE, 2010	
	CO2 from carbonation of dolomite (CaMg(CO3)2)	0.4530	kg CO2 /kg dolomite appied	DCCEE, 2010	
Emissions to water	Nitrogen (N) fraction prone to runoff/ leaching	0.6560	kg N/kg N applied	DCCEE, 2010	
	Nitrogen (N) exported via runoff and leaching	0.3000	kg N/kg N applied	DCCEE, 2010	
	Phosphorous (P) exported via runoff	0.1280	kg P/kg P applied	Bloesch et al (1997)	
	Pesticide (active ingredients) exported via runoff and leaching	0.0150	kg AI/kg AI applied	Hamilton and Haydon (1996)	
	Fraction of lost sugar exported to runoff in post-harvest rainfall events	0.5000	kg sucrose/kg in-field sugar loss	estimate	

Reviewing results

Sheet 9 - Input Summary

This worksheet reports the key cane growing input and output parameters generated by the tool, based on the data entered by the user. See an example in Figure 19.

It summarises the inputs of resources to the farming operation (fuel, electricity, nutrient products, pesticides, water, transport) and the output to the environment from the farming operation (nitrogen, phosphorus, pesticides, cane burning emissions).

The user can review these values to check that data has been entered correctly, that it correctly represents the farm or scenario being assessed. If necessary the user can go back to the data entry sheets to adjust the entered values.

The 'calculated parameters' in the ORANGE-shaded celled on the right hand side of this worksheet report the parameters per tonne of cane harvested sugarcane. These values can be exported to other LCA software tools, such as the LCA model for sugarcane milling (developed by QUT) and more general LCA software (Simapro, Gabi, etc.).

Sheet 10 - Results

This worksheet reports the final results from the life cycle assessment. See an example in Figure 20.

The results are presented as a bar graph depicting the environmental profile of the assessed farm, for the five key environmental indicators - FOSSIL FUEL USE, CARBON FOOTPRINT, WATER USE, and WATER QUALITY RISKS (from nutrients and from toxic substances).

The total length of each bar represents the scale of the impact compared with expected industry maximums. For example, a 50% result for carbon footprint means the assessed farm has a carbon footprint that is 50% less than the expected highest for the industry, per tonne of harvested cane.

The colour coding on the bars shows the sources of environmental impacts. The user can click on the coloured sections to identify the corresponding activity from the legend below the graph.

The eco-efficiency ratings to the right of the graph give a simple indication of the relative eco-efficiency of the assessed farm, on a 5-star scale. A 5-star rating denotes the highest eco-efficiency performance, representing less than 20% of the expected maximum impact for sugarcane growing in Australia. Refer to Table 10 for the performance criteria for each rating.

Table 10 Performance criteria for 5-star rating scale (% of expected maximums for sugarcane growing in Australia)

½ star	1 star	1 ½ star	2 star	2 ½ star	3 star	3 ½ star	4 star	4 ½ star	5 star
95-100%	90-95%	80-90%	70-80%	60-70%	50-60%	40-50%	30-40%	20-30%	<20%

Details of the methods used to generate the results can be found in a separate document, titled Methods for CaneLCA Eco-efficiency Calculator, which can be obtained by contacting Marguerite Renouf (m.renouf@uq.edu.au).

The user can interpret the following from the environmental profile graph:

- the contributions that different activities make to each of the eco-efficiency indicators;
- the relative performance of the assessed farm, when compared with known ranges for sugarcane growing in Australia; and
- opportunities for improving the eco-efficiency of the assessed farm.

Different combinations of cane-growing practices can be assessed and compared to test if a proposed practice change will result in improved eco-efficiency.

To enable this, the environmental profile graph can be exported to other documents (copy and paste) so that results from multiple assessments to be easily compared alongside eachother.

Sheet 9 – Input Summary and Sheet 10 – Results can also be easily printed as a record of the assessment.

Figure 19 Example input summary

1. Farm details

Farm name:	Hypothetical	Region not specified
Scenario:	Hypothetical	
Comments:		

Assessor's name	
Assessment date:	5/05/2013
CaneLCA version:	V1 (Issued 05/05/2013)

Farm areas included in the assessment:	Area identifier	Area (ha)	Harvested yield (t/ha)	Harvested production (t)
	Plant cane	20	110	2,200
	Ratoon cane	80	91	7,300
	Break crop	20		50
	Interrow crop			
	Fallow			
	Headland	5		
	Other			
	Total farm area:	**125**	**Cane production:**	**9,500**

Practices employed:	Row spacing (m):	1.5	
	Soil management:	Best practice	
	Nutrient management:	Best practice	
	Pest management:	Best practice	
	Harvesting:	Burnt cane harvesting	0%
		Green cane harvesting	100%
	Irrigation:	Furrow	

8. Emission factors

	Species lost to the environment		
Emissions to air:	Nitrous oxide (N2O) from direct denitrification of applied nitrogen (N)	0.013	kg N2O-N/kg N applied
	Nitrous oxide (N2O) from indirect denitrification of redeposited nitrogen (NH3 and NOx)	0.010	kg N2O-N/kg N redeposited
	Nitrous oxide (N2O) from indirect denitrification of nitrogen lost through leaching and runoff	0.013	kg N2O-N/kg N leached/ ruoff
	Ammonia (NH3) from volatilisation of fertiliser-N surface-applied to bare soil	0.131	kg N/kg N surface-applied
	Ammonia (NH3) from volatilisation of fertiliser-N surface-applied to trash blanketed soil	0.231	kg N/kg N surface-applied
	Ammonia (NH3) from volatilisation of dunder-N surface-applied to bare soil	0.088	kg N/kg N surface-applied
	Ammonia (NH3) from volatilisation of dunder-N surface-applied to trash	0.163	kg N/kg N surface-applied
	CO2 from carbonation of limestone (CaCO3)	0.396	kg CO2/kg limestone applied
	CO2 from carbonation of dolomite (CaMg(CO3)2)	0.453	kg CO2 /kg dolomite appied
Emissions to water:	Nitrogen (N) exported via runoff and leaching	0.300	kg N/kg N applied
	Phosphorous (P) exported via runoff	0.128	kg P/kg P applied
	Pesticide (active ingredients) exported via runoff and leaching	0.015	kg AI/kg AI applied
	Fraction of lost sugar exported to runoff in post-harvest rainfall events	0.500	kg sucrose/kg in-field sugar loss

Assets in service:			
	Machinery (units):	Tractors	3
		Cane harvesters	1
		Other harvesters	1
		Trucks	1
		Planes	1
		Helicopters	
		Implements	13
	Irrigation infrastructure (ha):	Travelling gun	100
		Furrow	
		Hand shift	
		Travelling boom	
		Centre pivot	
		Lateral move	
		Drip irrigation	

Calculated parameters	
0.092	kg tractor / t cane
0.003	kg cane harvester / t cane
0.001	kg other harvester/ t cane
0.001	kg truck / t cane
0.000	kg plane/ t cane
0.000	
0.041	kg implement / t cane
0.011	ha travelling gun irrigation / t cane
0.000	
0.000	
0.000	
0.000	
0.000	
0.000	

2. Fuel use for on-farm tractor, truck and vehicle operation

				Plant cane	Ratoon cane	Break crop	Interrow crop	Fallow	Headland	Other
Soil work	Soil work for crop establishment	Diesel / bio-diesel	L	5,625	1,714	172				
Nutrient management	Applying nutrient products	Diesel / bio-diesel	L	163	500					
Pest management	Applying pesticides and weed control	Diesel / bio-diesel	L	250						
Harvesting	Harvest and haulout of cane and break crops		L	2,284	8,468					
Other activites	Headland slashing	Diesel / bio-diesel	L	1,200						
	Farm vehicles	Diesel / bio-diesel	L	1,500						
		Petol / ethanol	L	100						
	Total farm fuel use	**Diesel / bio-diesel**	**L**	**21,875**						
		Petol / ethanol	**L**	**100**						

Calculated parameters	
0.79	L diesel / t cane (soil work)
0.07	L diesel / t cane (nutrient app.)
0.03	L diesel / t cane (pesticide app.)
1.13	L diesel / t cane (harvest / haulout)
0.13	L diesel / t cane (slashing)
0.16	L petrol / t cane (farm vehicles)
0.01	L diesel / t cane (farm vehicles)
2.30	**L diesel / t cane (total)**
0.01	**L petrol / t cane (total)**

3. Nutrient management

				Plant cane	Ratoon cane	Break crop	Interrow crop	Fallow	Headland	Other	Calculated parameters
Nutrient products applied	Mill by-products and organic fertilisers	Dunder	m^3	3,465	8,870						1.30 m3 dunder / t cane
		Mill mud	m^3								0.00
		Ash	m^3								0.00
		Mill mud/ ash mix	m^3								0.00
	Syntheic fertilisers	Urea	kg	5,567	19,584						2.65 kg urea / t cane
		Diammonium phosphate (DAP)	kg	895	3,578						0.47 kg DAP / t cane
		Potassium chloride (KCl)	kg	1,146	4,584						0.60 kg KCl / t cane
		Ammonium sulphate (Granam)	kg	620	2,478						0.33 kg Gran-am/ t cane
	Ameliorants	Lime (agricultural)	t	25							0.00 t lime / t cane
		Dolomite	t								0.00
		Gypsum	t								0.00
Nutrients applied	N sources	Organic fertilisers / mill by-products	kg	2,310	7,392						1.02 kg N from mill by-products / t cane
		Synthetic fertilisers	kg	600	3,000						0.38 kg N from fertilisers / t cane
		Nitrogen fixation by legume crops	kg			1,000					0.11 kg N from legume fixation / t cane
		Crop residues (cane and break crops)	kg	1,100	3,650	1,392					0.65 kg N from crop residues / t cane
	Total N	N	kg	4,010	14,042	2,392					2.15 kg N applied (total)/ t cane
	Total P	P	kg	210	840						0.11 kg P applied / t cane
	Total K	K	kg	1,380	4,896						0.66 kg K applied / t cane
	Total S	S	kg	306	1,080						0.15 kg S applied / t cane
Transport effort for supplying nutrients	Shipping	overseas frieght	tkm	80,554	290,017						39.01 tkm shipping / t cane
	Truck (articulated)	general road freight	tkm	1,583	6,065						0.81 tkm bulk rail / t cane
	Rail	bulk rail freight	tkm	1,342	5,368						0.71 tkm articulated truck / t cane
	Rigid truck	25t load	tkm	1,250							0.13 tkm rigid truck (25t load) / t cane
		12t load	tkm								0.00
		5t load	tkm	30	150						0.02 tkm rigid truck (5t load) / t cane
Emissions to the environment	Nitrous oxide (N_2O) to air	from applied N	kg	57.2	204.1						0.03 kg N2O from applied N/ t cane
		from crop residues	kg	13.8	45.6						0.01 kg N2O from residues / t cane
		from leaching / runoff	kg	11.2	40.2						0.01 kg N2O from leached/runoff N / t cane
		from redeposition of volatilised N	kg	0.8	3.0						0.00 kg N2O from redeposited N / t cane
	Carbon dioxide (CO_2) to air	from lime / dolomite	kg	9,900.0							1.04 kg CO2 from lime/ dolomite / t cane
	N to water	to leaching / runoff	kg	572.7	2,045.1						0.28 kg N to runoff / t cane
	P to water	to runoff	kg	26.9	107.5						0.01 kg P to runoff / t cane

4. Pest management

				Plant cane	Ratoon cane	Break crop	Interrow crop	Fallow	Headland	Other	Calculated parameters
Pesticide active ingredients (AI) applied	Herbicides	2,4 D	kg		49.6						5.22 g 2,4 D/t cane
		Ametryn	kg	30.0							3.16 g ametryn/t cane
		Asulam	kg								0.00
		Atrazine	kg	138.0							14.53 g atrazine/t cane
		Diuron	kg								0.00
		Fluroxypyr	kg		20.8						2.19 g fluroxypyr/t cane
		Glyphosate	kg								0.00
		Hexazinone	kg								0.00
		Imazapic	kg								0.00
		Isoxaflutole	kg								0.00
		MCPA	kg								0.00
		Metolachlor	kg								0.00
		Metribuzin	kg								0.00
		MSMA	kg	10.0							1.05 g MSMA/t cane
		Paraquat	kg	27.3							2.87 g paraquat/t cane
		Pendimethalin	kg								0.00
		Trifluralin	kg								0.00
	Insecticides	Aldicarb	kg								0.00
		Carbaryl	kg								0.00
		Chlorpyrifos	kg								0.00
		Fipronil	kg	1.5							0.16 g fipronil/t cane
		Imidacloprid	kg	15.0							1.58 g imidaclorprid/t cane
	Fungicides	Mercury (Memc)	kg								0.00
		Propiconazole	kg	0.5							0.05 g propiconazole/t cane
Emissions to the environment	Herbicide AI	to runoff	kg	3.1	1.1						0.44 g herbicide AI/ t cane
	Insecticide AI	to runoff	kg	0.2							0.03 g insecticide AI / t cane
	Fungicide AI	to runoff	kg								0.00
Transport effort for supplying pesticides	Shipping	overseas frieght	tkm	2,668	845						0.37 tkm shipping / t cane
	Articulated truck	general road freight	tkm	764	285						0.11 tkm truck / t cane
	Rigid truck	general road freight	tkm	8	3						0.00 tkm truck / t cane

5. Harvesting

Fate of harvest residues	Removed		%							
	Burnt pre- or post-harvest		%							
	Retained		%	100%	100%	100%				
Emissions to the environment	Methane (CH_4) to air	from cane burning	kg							0.00
	Nitrous oxide (N_2O) to air	from cane burning	kg							0.00
	Nitrogen oxides (NOx) to air	from cane burning	kg							0.00
	Carbon monoxide (CO) to air	from cane burning	kg							0.00
	Volatile organic compounds (VOC) to air	from cane burning	kg							0.00
	Sugar loss to water	from harvesting	kg	22	72					0.01 kg sugar loss / t cane

6. Water management

Water pumped	Water extracted	Dam	ML							0
		Ground	ML							0
		River	ML							0
		Irrigation scheme	ML				280			29 kL scheme water / t cane
		Total	**ML**				**280**			29 kL total water extracted / t cane
	Other water management activities	Water reclamation	ML				54			6 kL water reclamation / t cane
		Dewatering	ML							0
Energy for pumping	Electricity for pumping		kWh				12,717			1.34 kWh electricity / t cane
	Diesel for pumping		L				4,819			0.51 L diesel / t cane

Figure 20 Example Results

10. Results

The graph shows the environmental profile of the assessed farm for five key environmental indicators.

The total length of each bar represents the scale of the impact compared with expected industry maximums. For example, a 50% result for carbon footprint means the assessed farm has a carbon footprint that is 50% less than the expected highest for the industry, per tonne of harvested cane.

The colour coding on the bars shows the sources of environmental impacts. Click on the coloured sections to identify the corresponding activity from the legend below.

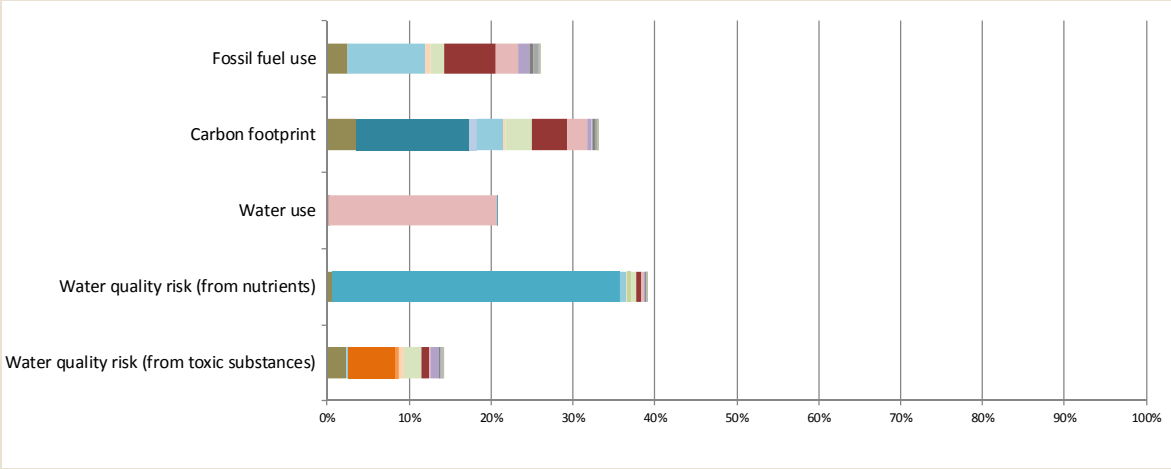
The eco-efficiency ratings to the right of the graph give a simple indication of the relative eco-efficiency of the assessed farm – a 5-star rating being the best.

Farm name: Hypothetical

Scenario: Hypothetical

Date: 5/05/2013

Environmental profile of the sugarcane operation (% of expected maximums for sugarcane growing in Australia)



Eco-efficiency Rating

Fossil fuel use	★★★★½
Carbon footprint	★★★★☆
Water use	★★★★½
Water quality risk (from nutrients)	★★★★☆
Water quality risk (from toxic	★★★★★

Tractor, truck, vehicle operation	Fuel use	Water management	Energy for pumping water on farm
Nutrient management	Nitrous oxide (N_2O) from denitrification of N (to air)		Water supply (including energy for upstream pumping of water)
	Carbon doxide (CO_2) from carbonation of lime (to air)	Capital goods	Production of machinery
	Nutrient (N and P) emissions (to water)		Production of on-farm irrigation infrastructure
	Production of synthetic fertilisers and ameliorants	Transport	Transport of fertilisers (shipping from overseas)
Pesticide management	Emissions of herbicide (to water)		Transport of fertilisers and ameliorants (road freight)
	Emissions of insecticide (to water)		Transport of fertilisers and ameliorants (rail freight)
	Emissions of fungicide (to water)		Transport of fertilisers and ameliorants (local truck delivery)
	Production of pesticides		Transport of pesticides (shipping and road freight)
Harvesting	Cane burning emissions (to air)		
	Organic emissons (to water) from sugar loss		
	Cane harvester operation		
	Harvester operation for other crops		